Attachment 1

MEASUREMENT AND CONTROLS DATA ACQUISITION SYSTEM SPECIFICATIONS

MARSHALL SPACE FLIGHT CENTER

National Aeronautics and Space Administration
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TABLE OF CONTENTS

1.0 OBJECTIVE:

NASA is pursuing procurement of a data acquisition system for use in a propulsion testing environment. This system is intended for implementation in Marshall Space Flight Center (MSFC) supporting NASA Test Programs.

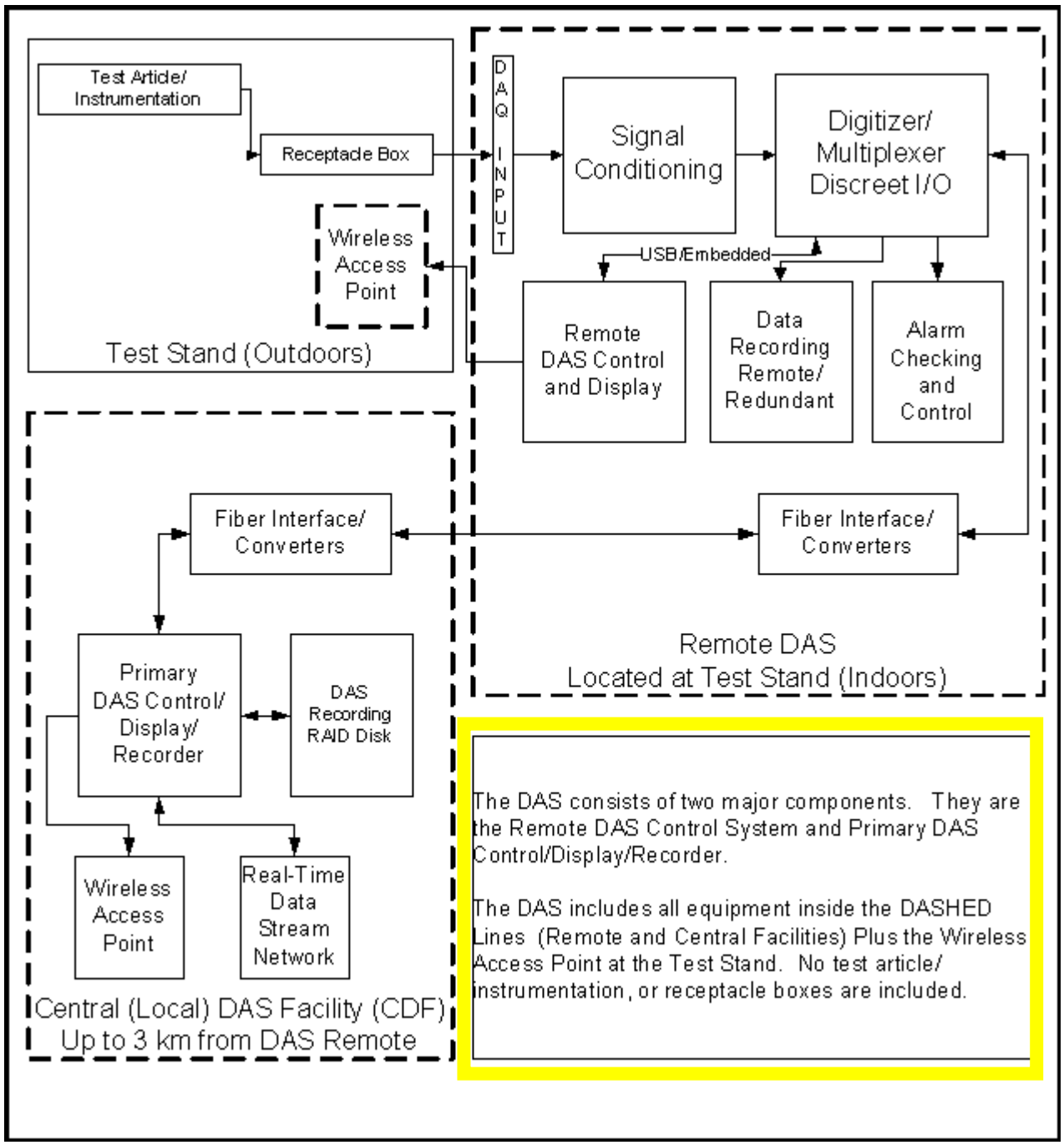

Figure 1: MCDAS Conceptual Block Diagram

2.0 DEFINITIONS, ACRONYMS, STANDARDS AND SPECIFICATIONS:

2.1 Definitions and Acronyms

2.1.1 API: Application Programmer Interface
2.1.2 AWG: American Wire Gauge
2.1.3 CMMR: Common Mode Rejection Ratio
2.1.4 CMV: Common Mode Voltage
2.1.5 DAQ: Data Acquisition
2.1.6 DLL: Dynamically Linked Library
2.1.7 EMI: Electromagnetic Interference
2.1.8 EU: Engineering Units
2.1.9 GUI: Graphical User Interface
2.1.10 IRIG: Inter-Range Instrumentation Group
2.1.11 MCDAS: Measurement and Controls Data Acquisition System
2.1.12 MTBF: Mean Time Between Failures
2.1.13 MTTR: Mean Time to Repair
2.1.14 NIST: National Institute of Standards and Technology
2.1.15 PDU: Power Distribution Unit
2.1.16 RCal: Resistance Calibration
2.1.17 RTI: Relative To Input
2.1.18 RTD: Resistance Temperature Device
2.1.19 RTO: Relative To Output
2.1.20 UDP: User Datagram Protocol
2.1.21 VCal: Voltage Calibration
2.1.22 WB: Wide Band

2.2 Standards and Specifications

2.2.1 EIA/TIA 568 For Fiber Optics
2.2.2 FCC Class A
2.2.3 Federal Information Processing Standards (FIPS) Publication 200
2.2.4 MIL-STD-1553
2.2.5 MIL-STD-810F, Section 514.5 and 516.5
2.2.6 NIST SP 800-53: Recommended Security Controls for Federal Information Systems and Organizations
2.2.7 NIST SP 800-40: Creating a Patch and Vulnerability Management Program
2.2.8 NPR 2810.1A: Security of Information Technology Chapters 2 and 11
2.2.9 NPD 2820.1C
2.2.10 NPR 7150.2

3.0 SCOPE:

This document describes the requirement specification for the design, performance, functionality and acceptance criteria of the Measurement and Controls Data Acquisition System (hereafter referred to as, MCDAS). All mounting hardware, mating connectors and any related software,

documentation and hardware necessary for the intended operation, installation, trouble shooting, and maintenance shall be included as part of this requirement.

The MCDAS system described in this document will serve as the base configuration for the Low Speed and the High Speed DAS. The vendor shall provide the hardware to accomplish Data Acquisition using the same basic chassis, power supplies, and field interchangeable peripherals, except where noted below.

The Vendor shall be responsible for delivery of system components (hardware and software) required by specification to MSFC. MSFC representatives will assemble the systems and perform System Verification as defined by paragraph 9.0.

3.1 General Requirements: High Speed/Low Speed DAS

3.1.1 The system shall guarantee no data loss with respect to acquiring data, converting, and recording to disk. There shall be no gaps (missing samples) in the recorded data.

3.1.2 The system shall implement a distributed measurement, display, and recording architecture approach.

3.1.3 The system shall have a modular and scalable design that allows for augmentation of the system in an incremental method. This design shall permit the breakdown of a large channel count configuration into smaller independent modules and vice versa.

3.1.4 The system shall support synchronized data acquisition, conversion, and storage of data from remote location(s). These locations can be up to 3 kilometers apart.

3.1.5 The system, as a minimum, shall read analog and discrete signals, convert them to a digital format, display acquired data in alphanumeric and graphical representations, and record to disk storage.

3.1.6 The system shall include a filtering capability that prohibits any measurable aliasing to occur.

3.1.7 The system shall have data storage capacity expandable to meet test requirements.

3.1.8 The system shall have a backup/restore and archive capability that will allow for unattended data backup to secondary storage and unattended restore from secondary storage to primary storage.

3.1.9 The system shall be capable of being configured, controlled, and operated as an isolated standalone system.

3.1.10 All system components will be available as options per this specification (racks, communications equipment, cables, connectors, etc.).

3.1.11 The system shall be composed of commercially available hardware utilizing an open architecture approach (e.g., PCI, VME, VXI, etc.).

3.1.12 The system shall include the integration of other industry standard data streams into the data acquisition, conversion, distribution, display, and recording process. These data streams shall include: WinPlot, Ethernet, and MatLab.

3.1.13 The system shall be able to operate both high speed and low speed integrated hardware using a single software application.

3.1.14 Measurement Uncertainty Analysis document will be delivered with the purchased system. The standard by which it was performed will be noted.

4.0 SOFTWARE SPECIFICATIONS:

The Vendor supplied software must support both the Low Speed and High Speed data system hardware including both the operations requirements in Section 4.0 and hardware requirements in Section 5.0.

4.1 Overview

4.1.1 The software system shall provide a graphical user interface to functionality that will accomplish test configuration and setup, calibration, acquisition, alarming, display, recording, distribution, reporting, playback, logging, and data export and backup.

4.1.2 Additionally, the software system shall be able to perform hardware maintenance/troubleshooting functionality as a tool for system diagnosis and checkout.

4.1.3 The software shall adhere to or be modifiable to meet required MSFC – NASA IT security policies. The scope and implementation of required modifications will be determined by the NASA customer.

4.1.4 Software supports an update path to allow for future hardware in a way that existing NASA written code will not be broken.

4.1.5 Software shall support all DAS system functionality for both Primary (in Central DAQ Facility) and Remote (at Test Stand) operations.

4.1.6 Automatic detection, reporting and configuration of installed channel types and capabilities.

4.2 Programmer Interface

In addition to the software package, the Vendor must support an Application Programmer Interface (API) architecture in the following ways:

4.2.1 The vendor shall provide software drivers or APIs for use with the NASA supplied application programs. All system setup and operational parameters shall be controlled through a standard Microsoft DLL type interface.

4.2.2 API shall support the generation of all software screens using a single API command with an integer argument.

4.2.3 API shall be capable of setting and reading back any user enterable value in the software.

4.2.4 API shall be useable from any Microsoft Windows application that supports DLL calls.

4.2.5 Shall support standard programming languages such as C, C++, Visual Basic, and Lab View.

4.2.6 API shall provide callback functions that automatically give application using the API access to current values in engineering units and mV as well as access to all unconverted raw data in real time.

4.2.7 API shall provide higher level functions that allow the application to perform user operations using API function calls.

4.3 IT Security

4.3.1 The software application should be capable of meeting IT Security specifications and demonstrate conformance with NASA Software Policy, NPD 2820.1C.

4.3.2 The software application should be capable of User Authentication in accordance with NPR 2810.1A: Security of Information Technology Chapter 11, NIST SP 800-53: Recommended Security Controls for Federal Information Systems and Organizations, and Federal Information Processing Standards (FIPS) Publication 200.

4.3.3 The software application should be capable of updating Security Patches in accordance with NPR 2810.1A: Security of Information Technology Chapter 2 & 11 and NIST Special Publication 800-40: Creating a Patch and Vulnerability Management Program.

4.3.4 The software application must be capable of supporting current 32-bit Microsoft Operating Systems (XP Pro, Windows 7, etc.).

4.3.5 Software must support a user account methodology to set user defined roles and restrictions (with password login) that provide different levels of access to the hardware.

4.4 Command Interface

4.4.1 The software shall be capable of performing a diagnostic/health check of the hardware and generating a report.

4.4.2 The system shall provide a programmable interface. The programmable interface to the control subsystem shall conform to one of the following communication methodologies, listed in order of preference:

4.4.2.1 Ethernet via TCP/IP.

4.4.2.2 Ethernet via UDP (User Datagram Protocol).

4.4.2.3 USB (conforming to version 2.0 or higher).

4.4.2.4 Fiber Channel.

4.4.3 The programmable interface shall support the following functions as a minimum:

4.4.3.1 Auto-balance of bridge type transducers.

4.4.3.2 Signal Conditioning status, with the following status conditions being reported, as a minimum:

4.4.3.2.1 Mode of Signal Conditioning (i.e.; in calibration mode or signal processing mode).

4.4.3.2.2 Overload status.

4.4.3.2.3 Gain setting.

4.4.3.2.4 Filter setting.

4.4.3.2.5 AC or DC coupling status.

4.4.3.2.6 Excitation status, current or voltage, enabled or disabled.

4.4.3.2.7 Excitation value, current or voltage.

4.4.3.2.8 Status of the programming interface (active/inactive).

4.4.3.2.9 Value of input voltage signal.

4.4.3.3 All remote programmable functions shall have local and remote GUI-based panel programmability. All setting values shall be saved in nonvolatile memory for future use. Implicit and explicit system commands and anticipated response shall be fully described. Remote programmability (from host computer) is required for the following functions:

4.4.3.3.1 Accept settings for acquisition parameters, such as scan rates, sample rates, scan periods, and clock, etc.

4.4.3.3.2 Independent, individual channel selection.

4.4.3.3.3 Range of channels to be selected, per applicable functions.

4.4.3.3.4 Local system lockout (enable/disable).

4.4.3.3.5 Signal Conditioning automatic features, as applicable, per module type (excitation level, bridge balance, zero offset, gain adjust, shield connection, etc.).

4.4.3.3.6 Restore all stored settings to all channels after power fail recovery.

4.4.3.4 Initiate performance of an internal calibration using an internal or external source and store results locally and remotely.

4.4.3.5 Initiate performance of an external calibration and store results. External calibration shall include:

4.4.3.5.1 Connect to an external calibration source.

4.4.3.5.2 Removal of connection from an external calibration source.

4.4.3.5.3 Accept a setting for a Gain command.

4.4.3.5.4 Accept a setting for a Filter command.

4.4.3.5.5 Initiate performance of external calibrations, including shunt, voltage, current, etc.

4.4.3.5.6 Removal of external calibration state.

4.5 Test Support Functionality

4.5.1 Setup:

4.5.1.1 Ability to read and write from/to an ODBC compliant database, or spreadsheet for setup information.

4.5.1.2 A GUI for programming channel parameters and sample rates that configures automatically for the selected channel and provides a copy function for simultaneously programming multiple similar channels.

4.5.1.3 Provide the ability to download and upload channel settings from/to a database.

4.5.1.4 Document system hardware settings to a database or delimited text file with all information required to recreate a previous test configuration.

4.5.1.5 Select/ deselect any installed channels for recording without reconfiguring the system.

4.5.1.6 Display channel settings (sample rate, filter, gain, calibration, name, description, etc) for a particular channel of interest.

4.5.1.7 Ability to name channels with a minimum of 16 alphanumeric characters, e.g. UTR_THV_TYPEK_40.

4.5.1.8 Ability to name and save setup, calibration, raw, and processed files.

4.5.1.9 The ability to store these named files to selectable directory folders.

4.5.1.10 Ability to create new pseudo (calculated) channels (and display them) by performing calculations on the data that is being recorded.

4.5.1.11 Ability to define, edit, import and export customized calculation functions, used by the pseudo channel.

4.5.1.12 Ability to set up and save Scripts (Macros) to automate repetitive data processing, setup, and acquisition procedures.

4.5.1.13 Ability to select/copy data channel(s) parameters with automated naming update.

4.5.1.14 The ability to define, name, import and export customized conversion tables.

4.5.2 Calibration:

4.5.2.1 Operating time shall be such that no greater than 15 minutes will be required to perform a calibration on 1000 channels utilizing any combination of internal and/or external calibration sources.

4.5.2.2 User calibration of system with capability for traceability to NIST.

4.5.2.3 When power is removed from a chassis, previous channel-specific settings shall be automatically recovered for the affected chassis.

4.5.2.4 Provide automated calibration and overall health checks with display and reporting of calibration data with indication of channels failing health check.

4.5.2.4.1 Health check verification with traceability to an external NIST programmable voltage source to 0.05% of full scale.

4.5.2.5 External Calibration:

4.5.2.5.1 For Resistance substitution, the user selectable resistance shall be available at the programmable interface.

4.5.2.5.2 For Voltage substitution, the user selectable voltage shall be available at the programmable interface.

4.5.2.5.3 Ability to import electronically, information to populate instrumentation parameters from metrology calibration data.

4.5.3 Acquisition and Conversion Characteristics:

4.5.3.1 Regardless of the system sample rate increment, the following sample rates will be provided: 1, 2, 5 steps per decade, binary or decimal starting at 1 to a minimum of 1,000 S/sec for low speed and 200,000 samples per second with a bandwidth up to 100kHz for high speed.

4.5.3.2 Sample rates shall be selectable per card assembly.

4.5.3.3 The time an event signal is present at the input to the time the signal is available to the host computer shall be no more than 2 times the scan rate for low speed.

4.5.3.4 ≥6th Order Polynomial real-time Engineering Unit Data Conversion. Provide conversion of signal conditioner output to engineering units using a sixth (or higher) order quadratic equation and user installed look-up tables.

4.5.3.5 NIST thermocouple tables shall be used for temperature measurements.

4.5.3.6 Universal Thermocouple Referencing shall be supported in both hardware and software configuration.

4.5.3.7 Ability to distribute the real-time data stream to (MSFC developed) WinPlot and (NASA) PCGoal, in addition to the COTS software specified.

4.5.4 Alarming:

4.5.4.1 Discrete inputs shall indicate change of state within less than 3 ms of application of signal.

4.5.4.2 Ability to perform Alarm checking on raw data (fast alarming).

4.5.4.3 Ability to perform Alarm checking on engineering units converted channel data as well as calculated (pseudo) channels (slow alarming).

4.5.4.4 Ability to monitor server(s) and front-end hardware via an alarm mechanism for status. Provide real-time display of system status (status, run time, run number, alarm, mark bit, etc.).

4.5.5 Recording:

4.5.5.1 Recorded data file shall contain data in raw (binary counts) format with a file header containing all setup and calibration information necessary to convert the raw data into NIST traceable engineering units.

4.5.5.2 The system shall support time stamping of data via an Inter-Range Instrumentation Group (IRIG)-B reference or optionally via a Global Positioning System reference. All recorded data shall be time stamped.

4.5.5.3 Capability shall be provided to time-tag all digitized data output from the signal conditioning and A/D conversion system with time of day derived from an external IRIG-B time code signal to a resolution equal to or better than the sample period.

4.5.5.4 Once a data file has been selected, the system shall display the time that the data started recording, the duration of the recording, and the setup data for that recording run and disk usage.

4.5.5.5 Provide preview mode that displays and distributes data without recording.

4.5.5.6 Record mode that records selected channels to hard drive and displays the amount of remaining disk space.

4.5.5.7 Acquired data stored on digital hard media on two independent pathways at the acquisition point and the control point.

4.5.6 Data Display:

4.5.6.1 Provide real-time data to multiple, Ethernet connected PC user displays.

4.5.6.2 User configurable displays.

4.5.6.2.1 Tabular/Numeric displays

4.5.6.2.2 Plots

4.5.6.2.2.1 Real-time displays plots to include, as a minimum, the functionality available in WinPlot.

4.5.6.3 Ability to configure, distribute, and display data on wireless devices, such as laptops, tablets, and hand-helds.

4.5.6.4 Multiple Variables per plot (up to four) with separate Y-Axis per variable.

4.5.6.5 Ability to seamlessly display (on ALL plots or numeric displays) calculated channels along with scanned analog channels.

4.5.6.5.1 Display a combination of raw values and/or

4.5.6.5.2 Engineering Units values

4.5.6.6 Over range status shall be provided in plot or numeric display for channels with inputs that exceed its full scale range.

4.5.6.7 Alarm status shall be provided with color-scheme.

4.5.7 Data Formats and Storage:

4.5.7.1 ASCII (Comma Separated Variable, Space Delimited, Tab Delimited)

4.5.7.2 Binary A/D output (Raw A/D counts)

4.5.7.3 Compatibility with WinPlot, MATLAB, and other industry standard display packages.

4.5.7.4 Ability to generate processed data files in NASA Sun Format.

4.5.8 Reports:

4.5.8.1 Ability to generate custom reports.

4.5.8.2 Ability to export report results into an electronic version of the report. (e.g. pdf)

4.5.8.3 Ability to generate reports of test setup configuration.

4.5.8.4 Ability to generate reports, based on wildcard selection(s).

4.5.8.5 Ability to generate reports for Internal Health Check results.

4.5.8.6 Ability to generate reports of External Calibration results.

4.5.9 Post Test Data Access:

4.5.9.1 Playback of stored data on all real-time plot types at selectable rate (adjustable playback speeds that are slower and faster than real-time).

4.5.9.2 Ability to transport processed files.

4.5.9.3 Ability to override setup file parameters to allow reprocessing of existing raw data.

4.5.9.4 High Speed DAS shall be capable of performing post-test processing utilizing a binary FFT minimum block size of 4096 points.

4.5.9.5 Ability to print test data reports.

4.5.10 System Logging:

4.5.10.1 Ability to log system events for application and server activity.

4.5.10.2 Ability to monitor system load (CPU utilization, memory, etc.).

5.0 HARDWARE SPECIFICATIONS:

5.1 System Connectivity

5.1.1 Control Interface:

5.1.1.1 Programming and Interface: The High Speed/Low Speed DAS shall provide a programmable interface. The programmable interface to the control subsystem shall conform to one of the following communication methodologies, listed in order of preference:

5.1.1.1.1 Ethernet via TCP/IP.

5.1.1.1.2 Ethernet via UDP (User Datagram Protocol).

5.1.1.1.3 USB (conforming to version 2.0 or higher).

5.1.1.1.4 Fiber channel.

5.1.1.2 Data Storage: The High Speed/Low Speed DAS data storage equipment shall be provided by the Vendor per the following requirements:

5.1.1.2.1 Recorded data shall be at least 16 bits.

5.1.1.2.2 The system shall be able to continue recording while data is being processed and/or transmitted.

5.1.1.2.3 Sufficient storage shall exist for continuous storage of test data at customers' specified configurations, with a minimum of 1 terabyte.

5.1.1.2.4 The ability to remotely retrieve all stored data.

5.1.1.2.5 Data shall be stored in real-time in raw (required) and/or EU (optional) converted format.

5.1.1.2.6 Ability to record raw data at test facility for redundancy. Redundant recording shall be independent of the functionality of the primary recording link.

5.1.1.2.7 Primary data storage systems shall require hardware RAID configuration, not to impact system throughput.

5.1.1.3 Acquisition Point Interface: High Speed/Low Speed DAS

5.1.1.3.1 The system shall be capable of initiating data acquisition start and/or stop based on a remote 4.5-28 volts signal from an external source.

5.1.1.3.2 The Primary and Remote enclosures shall be connected via fiber optic cable transceivers which meet minimum requirements for driving two megahertz/kilometer multimode cable, utilizing the ST fiber optic cable termination, and adhering to the EIA/TIA 568 or its' superseding standard.

5.1.1.3.3 The system shall have a local interface embedded in or attached to the Remote DAQ chassis at the test stand for local display and control.

5.1.1.3.4 The Remote DAQ Control/Display shall be capable of displaying the channel number and associated counts, hardware status (system health), and sample rate.

5.1.1.3.5 The system shall be capable of resetting via the Primary or Remote DAQ.

5.1.1.3.6 Each Remote DAQ chassis shall be capable of providing a minimum of thirty-two (32) programmable discrete I/O channels. Discrete inputs shall have a maximum input voltage range greater than 28 VDC. Discrete outputs shall energize within 2 scan periods of the programmed triggering channel receiving trigger level voltage.

5.1.2 Power: High Speed/Low Speed DAS

5.1.2.1 All equipment shall be powered by standard 120VAC (+/- 10%), 60Hz commercial power.

5.1.2.2 Each rack will have a dedicated power distribution unit (PDU) with minimum of six 110 volt outlets, a cumulative 30 ampere supply rating with optional remote monitoring and control.

5.1.2.3 The PDU and chassis power switches shall be easily accessible from the front or rear of the units.

5.1.3 Grounding: High Speed/Low Speed DAS

5.1.3.1 Recommended Grounding scheme required to be furnished with proposal. Grounding schemes shall include Chassis, Control Logic, Signal Conditioning, DC Control Power, and Instrumentation ground.

5.2 System Inputs

5.2.1 Signal Conditioning:

5.2.1.1 Reconfiguration of a High Speed/Low Speed DAS signal conditioning channel shall require the removal of not more than one module assembly from the chassis backplane.

5.2.1.2 The Low Speed DAS Signal Conditioning shall accept the following types of inputs:

5.2.1.2.1 One, Two and Four arm bridges, maximum of two inputs will share an isolated excitation source. Bridge assemblies will have a maximum of four channels per assembly.

5.2.1.2.2 Voltage and thermocouple inputs will have a maximum input of 32 (thirty-two) channels to share an assembly.

5.2.1.2.3 Resistance Temperature devices (RTDs) will have a maximum of eight channels per shared assembly.

5.2.1.2.4 An External Calibration Input.

5.2.1.3 The High Speed DAS Signal Conditioning shall accept the following types of inputs:

5.2.1.3.1 One, Two and Four arm bridges, maximum of two inputs will share an isolated excitation source. Bridge assemblies will have a maximum of two channels per card assembly.

5.2.1.3.2 An External Calibration Input.

5.2.1.3.3 The signal conditioning shall be capable of supporting traditional charge-mode piezoelectric transducers for vibration/accelerometer measurements. Additionally, the capability to pursue the advantages of Integrated Electronics PiezoElectric (IEPE) devices is also desired.

5.2.1.3.4 High Speed DAS Signal Conditioning shall be AC or DC coupled, selectable by the programming interface. This status shall be reported by the Signal Conditioning programmable interface.

5.2.1.3.5 High Speed DAS AC coupling High-Pass Filters shall attenuate at least -3 dB frequencies less than or equal to 1 Hz.

5.2.1.4 High Speed/Low Speed DAS inputs shall be capable of external voltage calibration which isolates the channel from the input and connects the external calibration source to the input.

5.2.1.5 High Speed/Low Speed DAS bridge completion type inputs shall accept 2-wire (voltage) signal configurations to 8-wire bridge (full strain gage) plus shield carried through to the plug-in card.

5.2.1.6 Excitation: High Speed/Low Speed DAS

The Signal Conditioning shall be capable of supplying the following types of transducer excitation:

5.2.1.6.1 Constant Voltage (programmable from 0 VDC to +10 VDC).

5.2.1.6.2 High Speed DAS - An optional configuration of 0 VDC to +/-28 VDC shall be made available. This shall be selectable via a purchase order.

5.2.1.6.3 High Speed DAS - Constant Current (Programmable from 0 to at least 15 mA).

5.2.1.6.4 The excitation power supply shall be independent of the amplifier power supply.

5.2.1.6.5 The excitation to be provided to the Bridge Signal Conditioning shall be measureable by the Signal Conditioning at the transducer.

5.2.1.6.6 Remote sense terminals shall be provided so that the Signal Conditioning can regulate the excitation voltage at the transducer or at the sense terminals.

5.2.1.7 Strain Gage/Resistive Bridge Completion Requirements: High Speed/Low Speed DAS

5.2.1.7.1 Calibration or bridge completion resistors are required to be supplied with the unit.

5.2.1.7.2 Solder terminals for bridge completion resistors and calibration components shall be provided on the card.

5.2.1.7.3 Bridge completion shall be configurable to accept 1, 2, or 4 arm active bridges.

5.2.1.7.4 Bridge Excitation: An excitation power supply, (when required), shall be an integral part of each Signal Conditioner, but isolated

from the amplifier power supply. Constant current and constant voltage shall be supported on the High Speed DAS Bridge circuits.

Characteristic	Constant Voltage	Constant Current
Range (minimum)	0 to 10 volts (minimum) 0 to 28 volts (optional)	0 to 15 mA
Excitation Limits	100 mA	10 Volts
Resolution	1 mV	50 μA

5.2.1.7.4.1 Balance (Voltage Excitation):

5.2.1.7.4.1.1 Manual and automatic bridge balance shall be provided as options.

5.2.1.7.4.1.2 Individual command of automatic balancing of bridge completion measurements shall be provided through the programmable interface.

5.2.1.7.4.1.3 This command shall not be executed as part of another command.

5.2.1.7.4.1.4 Balance shall be provided by a voltage insertion source at the input amplifier with resolution to 0.05% of span.

5.2.1.7.4.2 Programmable shunt calibration:

5.2.1.7.4.2.1 A programmable shunt calibration shall be provided.

5.2.1.7.4.2.2 The programmable shunt calibration shall be NIST traceable.

5.2.1.7.4.2.3 A method shall be provided to relate the programmable shunt calibration to a real resistor shunt value.

5.2.2 Instrumentation Amplifier:

5.2.2.1 Analog Inputs: Low Speed DAS

5.2.2.1.1 Input Voltage Range shall be not less than +/- 10VDC.

5.2.2.1.2 Voltage Gain shall include (but not be limited to) the following steps: 1, 2, 5, 10, 20, 50, 100, 200, 500, and 1000.

5.2.2.1.3 Common Mode Rejection Ratio (CMRR) shall be a minimum of -100 db, DC to 60Hz, at a gain of 10 or more. Minimum common mode rejection ratio shall be -80 db at any gain from DC to 60Hz.

5.2.2.1.4 Common Mode Voltage (CMV): Amplifier shall be capable of operating at a CMV to not less than ± 50V.

5.2.2.1.5 Input Impedance: Minimum input impedance shall be 10 MΩ.

5.2.2.1.6 Input Bias Current: Input bias current shall be a maximum of 10 nano-amperes at a temperature of 40°C.

5.2.2.1.7 Channel-to-channel crosstalk rejection shall be at least –80 dB, DC to 2 kHz between adjacent channels.

5.2.2.2 Analog Inputs: High Speed DAS

5.2.2.2.1 The Input voltage range shall be +/- 2mV to a maximum of +/- 10V.

5.2.2.2.2 Single A/D per channel.

5.2.2.2.3 System shall provide a sample rate of up to 200,000 samples per second with a bandwidth up to 100kHz.

5.2.2.2.4 System shall provide a minimum capability of 186 channels of test Data.

5.2.2.2.5 System shall provide a minimum sample rate of 100,000 sample per second for at least half (93) of the channels.

5.2.2.2.6 Voltage Gain shall include (but not be limited to) the following steps: 1, 2, 5, 10, 20, 50, 100, 200, 500, and 1000.

5.2.2.2.7 Common Mode Rejection Ratio (CMRR) shall be a minimum of -100 db, DC to 60Hz, at a gain of 10 or more. Minimum common mode rejection ratio shall be -80 db at any gain from DC to 60Hz.

5.2.2.2.8 Common Mode Voltage (CMV): Amplifier shall be capable of operating at a CMV to not less than ± 50V.

5.2.2.2.9 Input Impedance: Minimum input impedance shall be 10 MΩ.

5.2.2.2.10 Input Bias Current: Input bias current shall be a maximum of 10 nano-amperes at a temperature of 40°C.

5.2.2.2.11 Channel-to-channel crosstalk rejection shall be at least –80 dB, DC to 2 kHz between adjacent channels.

5.2.2.2.12 The system shall allow for redundant or parallel measurement of specified critical measurement.

5.2.2.3 Discrete Inputs: High Speed/Low Speed DAS

5.2.2.3.1 The system shall accept discrete inputs up to 32 VDC.

5.2.2.3.2 The system shall assign a logical “1” from an input of 4.5 to 32 VDC and a logical “0” from an input of 0 to 2 VDC.

5.2.2.3.3 Discrete inputs shall be optically isolated.

5.2.2.3.4 Discrete inputs shall detect a change of state within 0.5mS (relative to the scan rate) of application of signal.

5.2.2.4 Specialty Inputs (optional): The High Speed/Low Speed DAS types of signals shall be accepted and converted by either the base Signal Conditioning or a separate module. These options may be selectable at purchase order:

5.2.2.4.1 Thermocouples (Types E, J, K and T) with NIST traceable compensation.

5.2.2.4.2 Tickler circuits – Thermocouple cards shall have mounting provisions for the customer to install a "tickler" resistor (typically 100 K Ohms across the amplifier's high and low inputs) that will cause the amplifier to output full scale volts if the thermocouple transducer should transition to an open circuit.

5.2.2.4.3 RMS to DC conversion: This module shall accept an AC signal and convert it to an RMS voltage with a time constant of 20 mS (response to a step input to 70% of final value).

5.2.2.4.4 RMS to DC conversion modules shall have both AC and DC outputs (max outputs of 10VRMS and 10 VDC). Band pass filtering shall consist of programmable (4 pole or greater as selected via the purchase order) low pass and high pass filters with frequency ranges from 40 Hz to WB.

5.2.2.4.5 Frequency to DC conversion: This module shall accept an AC input with an unbalanced duty cycle and convert it to a DC voltage that is proportional to the frequency. This module shall have an adjustable threshold level.

5.2.2.4.6 Both the RMS to DC conversion and the Frequency to DC conversion functions shall have adjustable zero, gain, and frequency ranges. These adjustments shall be available at the programming and local interface.

5.2.3 Filtering: Low Speed DAS

5.2.3.1 Filter characteristics detailed below shall available via the purchase order.

5.2.3.1.1 Filtering shall be provided such that no measurable aliasing can occur at any given sample rate.

5.2.3.1.2 Bridge Signal Conditioning Filter options shall include, but not be limited to, the following programmable filter settings: 1, 5, 10, 15, 25, 50, 100, 1000 Hz and Wideband (unfiltered).

5.2.3.1.3 The "Wideband" setting shall pass frequencies up to at least 1 kHz (at -3db point) to 20 Volts peak-to-peak input.

5.2.3.1.4 Poles: 4 or greater, selectable via the purchase order.

5.2.3.1.5 Type: Bessel or Butterworth, selectable via the purchase order.

5.2.3.1.6 Accuracy: ± 10%; (-3db point at cut-off frequency).

5.2.4 Filtering: High Speed DAS

5.2.4.1 Filter characteristics detailed below shall be available via the purchase order.

5.2.4.1.1 Filtering shall be provided such that no measurable aliasing can occur at any given sample rate.

5.2.4.1.2 As a minimum, a six-pole low pass (36db/octave) filter with Butterworth characteristics and program-selectable settings. The amplifier bandwidth shall, as a minimum, be 100 kHz.

5.2.5 Calibration: High Speed/Low Speed DAS – As a minimum, the following calibrations shall be able to be performed. All calibration functions to be performed shall be NIST traceable and automated.

5.2.5.1 Shunt Calibrations:

5.2.5.1.1 The Signal Conditioning shall be capable of the following shunt calibration functions. In all cases, the value of the shunt resistor applied shall be equivalent to 80% of the channels full-scale range.

5.2.5.1.2 A monitor point for the excitation voltage shall be provided.

5.2.5.1.3 The Signal Conditionings shall provide selectable bridge configuration for the purpose of outfitting one conditioner with two different resistance bridge configurations (120 ohm, 350 ohm, 1000 ohm, etc.). Any bridge can be selected based on requirements to reduce transition time between tests.

5.2.5.1.4 Resistance Substitution:

5.2.5.1.4.1 Capability to perform calibrations in which a user selectable resistance substitution shall be required.

5.2.5.1.4.2 The user selectable resistance shall be available at the programmable interface.

5.2.5.1.4.3 The resistance substitution shall be NIST traceable.

5.2.5.1.5 Voltage Substitution:

5.2.5.1.5.1 Capability to perform calibrations in which a user selectable voltage substitution connection to an external voltage source shall be required.

5.2.5.1.5.2 The voltage substitution shall be NIST traceable.

5.2.5.1.5.3 Resolution for the voltage calibration shall be 0.01% of the selected excitation voltage range with 0.001% regulation.

5.2.5.1.5.4 The user selectable voltage shall be available at the programmable interface.

5.2.5.1.5.5 The capability to connect to an external voltage source shall be available at the programmable interface.

5.2.5.1.5.6 An output shall be provided for monitoring the value of the voltage being substituted.

5.2.5.1.6 Filtering, Analog-to-Digital Conversion, Sample Rate and Multiplexing:

5.2.5.1.6.1 The time a signal is present at the input to the time the signal is available to the host computer shall be no more than 100 mS in any configuration. The delay shall be no more than 10 mS with minimal channel configurations measured as a "step input" at the A/D input to the time the word is recorded on all recording media.

5.2.5.1.6.2 The Low Speed DAS sample rate shall be selectable from 1 to 1000 samples per second in 5 or less sps increments.

5.2.5.1.6.3 All channels shall be sampled simultaneously. The maximum inter-channel skew time shall be quantifiable, repeatable, and less than 80 microseconds.

5.2.5.1.6.4 Data shall be multiplexed digitally, with sufficient digital bandwidth to meet the selected sample rate.

5.2.5.1.6.5 Analog to digital conversion shall not be less than 16 bits.

5.2.5.1.6.6 The system shall be capable of accepting an IRIG-B time code input.

5.2.5.1.6.7 All data shall be time-tagged to IRIG-B within 100 microseconds of when the data was acquired.

5.2.5.1.6.8 Bandwidth shall not be less than 40% of the sample rate. Transition band attenuation shall not be greater than the design specification for the selected filter type.

5.3 System Outputs: High Speed/Low Speed DAS

5.3.1 Digital Outputs:

5.3.1.1 The system shall provide a digital output for access to the data.

5.3.1.1.1 Digital output may be USB 2.0 (or later), Ethernet or digital fiber channel.

5.3.1.2 Full data rate shall be supported by whatever method is selected.

5.3.1.3 Full specifications on data rate, output format and any command format shall be supplied.

5.3.2 Analog Outputs:

5.3.2.1 The Signal Conditioning shall comply with the following analog output requirements:

5.3.2.1.1 The Low Speed/High Speed DAS Bridge Signal Conditioning shall provide at least one buffered, unfiltered output available at an output connector.

5.3.3 Output Limitation: The outputs shall be limited to less than ± 10.5V full scale.

5.3.4 Output Impedance: The output impedance shall be no more than 50 Ω at a maximum of 100 pf capacitance measured at the output connector of the amplifier.

5.3.5 Capacitive Loading: Capacitive loading up to 0.22 μF shall not cause instability of the amplifier.

5.3.6 Drive Capability: Programmable Filtered output ± 10V at 5 mA; Wideband output ± 10V at 20 mA.

5.3.7 Output Protection: The amplifier shall not be damaged by a continuous short circuit on any output, and shall recover automatically when short circuit is removed. A short circuit that is present at any one of the outputs shall not damage itself nor offset other outputs.

5.3.8 Overload Detection: Overload detection for the Signal Conditionings shall have the following functionality:

5.3.8.1 Be a separate and dedicated capability for each Signal Conditioning channel.

5.3.8.2 The Signal Conditioning shall detect and report overload/over-voltage conditions.

5.3.8.3 Overload/over-voltage status shall be available at the programming interface.

5.3.9 Accuracy, stability, resolution, and I/O limitations:

5.3.9.1 Minimum Resolution: 16 bits (15 + 1 sign bit).

5.3.9.2 Basic Accuracy: ± (0.02% FS + 2uV) for 30 days at constant temperature after automatic calibration; includes the effects of gain error, offset, non-linearity and non-overloading crosstalk.

5.3.9.3 Gain Stability with Temp Change: ±0.002% FS/°C change from automatic calibration temperature.

5.3.9.4 Zero Stability with Temp Change: ±1.0uV/°C from automatic calibration temperature.

5.3.9.5 Input Configuration: Guarded differential input on each channel; floating or grounded signal sources measured without degradation.

5.3.9.6 Source Current: ± (1nA @ 23°C + 0.1nA/°C).

5.3.9.7 Input Overload w/o Damage: ±100VDC or peak AC, common mode or normal mode.

5.4 Environmental: High Speed/Low Speed DAS

5.4.1 Vibration:

5.4.1.1 The vendor shall indicate the maximum vibration capabilities of the proposed equipment.

5.4.2 Operating temperature and Electromagnetic Interference (EMI):

5.4.2.1 The complete assembly shall operate fully up to specifications over the temperature range of +5 °C to +40 °C.

5.4.2.2 The complete assembly shall operate fully up to specifications up to 90% non-condensing relative humidity.

5.4.2.3 The complete assembly shall be capable of being safely stored at temperatures ranging from -20 °C to +60 °C.

5.4.2.4 Electromagnetic Interference: The Systems shall comply with FCC Class A minimum EMI requirements.

5.4.2.5 Equipment shall operate properly with overall building air flow from the top of the equipment cabinet. This equipment is not intended to be installed on a raised floor.

5.4.3 Physical Specifications:

5.4.3.1 Rack Adapters:

5.4.3.1.1 Rack adapters shall be provided to facilitate mounting of the Amplifier/Signal Conditioning/Filter and digitizer modules in standard 19" equipment cabinets.

5.4.3.1.2 The rack adapter shall provide for interface of required connections; including electrical power, input signals, output signals, external calibration signals, facility and instrumentation grounding, and external host computer control.

5.4.3.2 Connectors and Wiring:

5.4.3.2.1 The preferred location for required external connections includes the rear panel of the rack adapter.

5.4.3.2.2 As a minimum, the following signals/controls shall be available at the rack adapter. The location, type, and pin-out of each connection type shall be identified in the quotation (or attachments). Connectors shall be MIL standard and comply with the following requirements:

5.4.3.2.2.1 Signal Input Connections:

Unless provided as coaxial BNC connections, transducer/signal input connectors shall include:

5.4.3.2.2.1.1 Input data signal for each individual Signal Conditioning channel.

5.4.3.2.2.1.2 Bridge excitation power for each individual Signal Conditioning channel.

5.4.3.2.2.1.3 Input connections shall be separate from the output, external calibration, monitor, programmable interface, and power connections.

5.4.3.2.2.1.4 Have pins that accept up to AWG 18 stranded wire.

5.4.3.2.2.1.5 The connector back-shell shall accept an outer diameter cable of up to 0.25" and shall provide a clamping mechanism for cable strain relief.

5.4.3.2.2.2 Calibration Connections:

5.4.3.2.2.2.1 An external calibration voltage connection shall be provided for each Signal Conditioning chassis.

5.4.3.2.2.2.2 External calibration connections shall be separate from the input, output, monitor, programmable interface, and power connections.

5.4.3.2.2.3 Signal Outputs Connections:

Unless provided as coaxial BNC connections, amplifier/filter output connectors shall include:

5.4.3.2.2.3.1 Wideband buffered output(s) for each Bridge Signal Conditioning channel.

5.4.3.2.2.3.2 Output connections shall be separate from the input, external calibration, monitor, programmable interface, and power connections.

5.4.3.2.2.4 Monitor Outputs:

Signal conditioning monitor outputs shall include:

5.4.3.2.2.4.1 Monitor points for all Signal Conditioning channel signal inputs, either at module or rack adapter.

5.4.3.2.2.4.2 Monitor points for all Signal Conditioning channel signal outputs, either at module or rack adapter.

5.4.3.2.2.4.3 Monitor points for all Signal Conditioning excitation voltages, either at module or rack adapter.

5.4.3.2.2.4.4 A monitor point at the local system for excitation, voltages, calibration voltages, inputs, outputs, etc. (if not already located on the front panel). This monitor point shall have a maximum resolution of 0.01% (i.e., 0.10 mV at 10V of the signal input).

5.4.3.2.2.4.5 Monitor output connections shall be separate from the input, output, external calibration, programmable interface, and power connections.

5.4.3.2.2.5 General:

5.4.3.2.2.5.1 Connectors shall be non-solder type connectors, keyed with positive locking mechanisms.

5.4.3.2.2.5.2 Connectors shall be made of non-oxidizing metal.

5.4.3.2.2.5.3 All *internal* mating connectors and cables required for system functionality shall be provided with the subsystem.

5.4.3.2.2.5.4 Mating connectors for all *external* connection/interface shall be fully described within the quotation (or attachments).

5.4.4 Footprint and weight (rack specifications, modular design, channel density):

5.4.4.1 Modular Design:

5.4.4.1.1 The Low Speed DAS system shall be expandable to a combination totaling 4096 analog and discrete channels.

5.4.4.1.2 Each Signal Conditioning module shall be changeable from the front of the rack adapter without the requirement to remove additional modules.

5.4.4.1.3 All Signal Conditionings shall be interchangeable in any chassis.

5.4.4.2 Channel Density/Cabinet Allocation:

5.4.4.2.1 Not less than one-hundred and sixty (160) analog input Low Speed channels shall be contained within one six (6) foot high standard 19" equipment cabinet.

5.4.4.2.2 Not less than one-hundred and sixty (100) analog input High Speed channels shall be contained within one six (6) foot high standard 19" equipment cabinet.

5.4.4.2.3 Each Low Speed bridge Signal Conditioning module shall contain no more than four (4) Signal Conditioning channels.

5.4.4.2.4 Each High Speed bridge Signal Conditioning module shall contain no more than two (2) Signal Conditioning channels.

5.4.4.2.5 Each voltage/thermocouple module shall contain no more than 32 channels per module.

5.4.4.2.6 Each RTD module shall contain no more than 8 channels per module.

5.4.4.3 Weight: Overall weight of an unpopulated chassis shall not exceed 50 lbs.

5.4.5 Reliability:

5.4.5.1 The system shall be designed to operate continuously with a maximum of 60 minutes of down-time for maintenance per failure.

5.4.5.2 The system should be highly reliable with a Mean Time Between Failure (MTBF) of 50,000 hours.

5.4.5.3 An automated diagnostic system will be supplied.

5.4.5.3.1 This system will operate autonomous from the control interface and be capable of testing all signal path field replaceable circuit assemblies. Testing will include all functionality including verification of calibrations.

5.4.5.3.2 The system will track metrics and historical data for all components testing.

5.4.5.3.3 Optional field testing appliances for trouble shooting DAQ modules.

6.0 DAS Channel/Component Quantity Requirements

The Systems will be inclusive of all hardware necessary for DAS operation including software, local and remote data distribution, mounting hardware, networking, and storage.

Each system will be configured as required per MSFC test requirements/preferences by MSFC personnel.

Systems will be assembled at MSFC by existing Test Area Personnel.

6.1 Low Speed DAS (Qty 5 DAS)

Each Low Speed Data Acquisition System will have the following basic configuration:

96 Channels of TC/Voltage
48 Channels RTD
356 Channels of Bridge
IRIG Timing Input
120 Channels of Discrete I/O

6.2 Low Speed Development DAS (Qty 1 DAS)

96 Channels of TC/Voltage
40 Channels of Bridge
32 Channels Charge Amplifier
32 Channels ICP/IEPE
32 Channels Digital Frequency/Counter
32 Channels RTD
96 Channels of Discrete I/O
Master and Slave Chassis (Channels to be distributed across master and slave chassis)
IRIG Timing Input

6.3 High Speed Data Acquisition System (Qty 2 DAS)

Each High Speed Data Acquisition System will have the following basic configuration:

100 Channels of Bridge
16 Channels of Discrete I/O
IRIG Timing Input

6.4 High Speed Development DAS (Qty 1 DAS)

32 Channels of Bridge
IRIG Timing Input
96 Channels of Discrete I/O
Master and Slave Chassis (Channels to be distributed across master and slave chassis)

6.5 Components Common to all High and Low Speed DAS:

6.5.1 External Voltage Source (Traceable) for Health Check - Voltage Standard (EDC 523 Programmable Cal Ref or equivalent) 1 each per DAS
6.5.2 Redundant Recording (Local/Remote) 1 each per DAS
6.5.3 Connectors (As required for channel types)

6.5.4 19" Racks as required for systems/channel counts – 1additional 19" Rack per DAS will be required for the termination of analog inputs.
6.5.5 Remote (Test Stand) Computer Interface – Qty 1 per DAS (All components 19" Rack mountable)
6.5.6 Local Interface (Primary Computer Systems) Qty 1 per DAS – CPU rack mountable, Qty 4 - 22" Displays per System, keyboard/mouse/monitor extensions 50'
6.5.7 DAS Turn-Key Software Site License

6.6 General Additional DAS Components

6.6.1 20 gauge copper - 8 Conductor Wire with shield - 30,000 feet
6.6.2 Fiber 12 Pair - 3000 feet
6.6.3 19" Racks – Qty 4 for Test Stand Peripheral Equipment
6.6.4 Wireless (Cisco Aironet 1142 w/ Omni Antenna or equivalent) Qty 6
6.6.5 Network Switch 1 GB (24 Port managed Switch - Cisco SRW2024P or equivalent) Qty 12
6.6.6 Industrial Grade Tablet Wireless Computers – (Qty 4)

6.7 Spares

Spares will include:

6.7.1 Qty 2 – DAS/Chassis Power Supply
6.7.2 Qty 2 – IRIG Input Module
6.7.3 Qty 2 – Redundant Storage Device
6.7.4 Qty 1 – Remote Control PC (Test Stand)
6.7.5 Qty 1 – Local Control PC (Primary Computer System)

6.8 Maintenance/Calibration/Verification

6.8.1 Maintenance/Calibration Station with Test Equipment (Hardware with Software) Qty 1
6.8.2 Agilent Function Generator for DAS Verification and Test (Agilent Function Generator or equivalent) Qty 3
6.8.3 Digital Multi-Meter (Keithly 2701or equivalent for DAS Verification and Test) Qty 3
6.8.4 Oscilloscope (Tektronic 1002B or equivalent for DAS Verification and Test) Qty 3

7.0 DOCUMENTATION:

The following documentation shall be provided:

7.1 General Documentation

7.1.1 A user's manual with instructions for all aspects of operation, including setup, recording, interfaces, connections, software, and data retrieval shall be provided in both hardcopy and electronic form.

7.1.2 The vendor shall provide written documentation, in both hard copy and electronic form, describing all software provided (application programs, application programming interfaces, and drivers) in sufficient detail to allow successful integration into NASA developed software.

7.2 Hardware Documentation (tech drawings)

7.2.1 A maintenance manual shall be provided that contains diagrams of system architecture, lists of spare parts, instructions for replacing parts and troubleshooting procedures.

7.3 Software Documentation

The vendor shall provide documentation describing the following specific aspects of the software:

7.3.1 Signal Conditioning Status Word Format.

7.3.2 Signal Conditioning Command Word Format.

7.3.3 The supplied API must include documentation to detail the High and Low level commands used to program the hardware.

7.3.4 Instructions for user customization of software, for example, DLLs, etc., including the following descriptions:

7.3.4.1 Descriptions and identification of command codes

7.3.4.2 Channel gain

7.3.4.3 Filter setting

7.3.4.4 Digital conversion rate

7.3.4.5 Initiation of all calibration modes:

7.3.4.5.1 Shunt Calibration

7.3.4.5.2 Resistance Substitution Calibration

7.3.4.5.3 Voltage Substitution Calibration

7.3.4.6 D/A Playback

7.3.5 The following are documentation requirements with which the vendor shall comply per NASA Procedural Requirements document NPR 7150-2:

7.3.5.1 Requirements that are to be met by the off-the-shelf software are identified within the software documentation provided.

7.3.5.2 The off-the-shelf software includes documentation to fulfill its intended purpose, such as usage instructions.

7.3.5.3 Proprietary, usage, ownership, warranty, licensing rights, and transfer are addressed within the software documentation.

7.3.6 The following documentation requirements shall apply only to software necessary to be developed to meet the specifications within this document that is in addition to existing software supplied by the commercial product:

7.3.6.1 The software vendor(s) shall provide insight into software development and test activities, including monitoring integration and verification adequacy,

trade study data, auditing the software development process, and participation in all software reviews and technical interchange meetings.

7.3.6.2 The software vendor(s) shall provide NASA all software products and software process tracking information, in electronic format, including all software development and management metrics.

7.3.6.3 The software vendor(s) shall notify NASA, in the response to the Request for Proposals, as to whether open source software will be included in code developed for the project.

7.3.6.4 The software vendor(s) shall provide NASA with electronic access to the source code developed for the project, including modified off-the-shelf software and non-flight software (ground test software, simulations, ground analysis software, ground control software, science data processing software, hardware manufacturing software, or other).

7.3.6.5 The software vendor shall track all software changes and provide the data for the project's review.

7.3.6.6 The software vendor(s) shall provide software metric data as defined in the project's Software Metrics Report.

7.3.6.7 NASA shall participate in any joint NASA/Vendor audits of the software development process and software configuration management process.

7.3.6.8 The software vendor(s) shall provide a software schedule for the project's review and updates as requested.

7.3.6.9 The software vendor(s) shall make available, electronically, the software traceability data for the project's review.

7.3.6.10 The software vendor shall document in the solicitation the software processes, activities, and tasks to be performed by the vendor.

8.0 TECHNICAL SUPPORT:

8.1 Hardware (Replacements and Repairs)

8.1.1 Overnight exchange for critical parts is required.

8.1.2 Standard repair or parts exchange will have a turnaround less than 30 days.

9.0 SYSTEM VERIFICATION SUPPORT:

9.1 FOB Destination Delivery to Marshall Space Flight Center, however, the vendor shall provide personnel to support onsite installation and system verification by the Government which is estimated at no more than two (2) weeks and a minimum two (2) technical representatives.

10.0 WARRANTY:

10.1 All items delivered under this contract/purchase order shall be warranted by the manufacturer's standard warranty and the warranty shall not be less than two years.

10.2 A copy of the manufacturer's standard warranty shall be enclosed in the package or included with shipping documents, as appropriate, for each warranted item delivered under this contract/purchase order.

10.3 Items warranted by the manufacturer's standard warranty shall be marked or stamped "Warranted". If space on the item is not available, the packing slip should state, as a minimum, the following:

10.3.1 Brief statement that a warranty exists.

10.3.2 Substance of the warranty.

10.3.3 Duration of the warranty.

10.3.4 Person to notify if the items are defective.

11.0 ACCEPTANCE CRITERIA:

11.1 Vendor shall provide a Quality Assurance acceptance test procedure to demonstrate compliance with the specifications prior to delivery. The procedure shall be submitted to NASA for approval. Test shall be performed at the vendor's facility with the option of government monitoring.

11.2 This test plan must include a Verification and Validation matrix which addresses the manner in which each requirement specified in this document is to be verified.

11.3 After assembly by MSFC personnel, System Verification shall be conducted at MSFC and the Vendor shall provide on-site personnel to support this effort as noted in 9.0 – System Verification Support.

12.0 TRAINING:

12.1 The vendor shall provide both onsite and offsite training for software and hardware products. As a minimum the offeror shall provide one (1) technical representative for two (2) weeks of on-site training for a minimum of fifteen (15) Marshall Space Flight Center (MSFC) representatives.

13.0 DATA PROCUREMENT DOCUMENT:

13.1 The vendor shall comply with the Measurement and Controls Data Acquisition System Specification, Data Procurement Document, Number 1340, Attachment 2.